GPS NAVIGATION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the invention

This invention relates to GPS navigation system; the system includes a dock (i.e. docking station) in combination with a portable navigation device. The navigation device can display travel information and finds particular application as an in-car navigation system.

2. Description of the prior art

GPS based navigation devices are well known and are widely employed as in-car navigation devices. Reference may be made to the Navigator series software from the present assignee, TomTom B.V. This is software that, when running on a PDA (such as a Compaq iPaq) connected to an external GPS receiver, enables a user to input to the PDA a start and destination address. The software then calculates the best route between the two end-points and displays instructions on how to navigate that route. By using the positional information derived from the GPS receiver, the software can determine at regular intervals the position of the PDA (typically mounted on the dashboard of a vehicle) and can display the current position of the vehicle on a map and display (and speak) appropriate navigation instructions (e.g. 'turn left in 100 m'). Graphics depicting the actions to be accomplished (e.g. a left arrow indicating a left turn ahead) can be displayed in a status bar and also be superimposed over the applicable junctions/turnings etc in the roads shown in the map itself. Reference may also be made to devices that integrate a GPS receiver into a computing device programmed with a map database and that can generate navigation instructions on a display. These integrated devices are often mounted on or in the dashboard of a vehicle. The term 'navigation device' refers to a device that enables a user to navigate to a pre-defined destination. The device may have an internal system for receiving location data, such as a GPS receiver, or may merely be connectable to a receiver that can receive location data.

The device is a portable device and hence has to be securely mounted onto a dock that is itself firmly attached to the dashboard or windscreen, usually with a suction cup.

The device is connected to an external aerial to pick up GPS signals (the term GPS covers not only US Navstar but other similar GNSS – Global Navigation Satellite System- systems such as Galileo). The RF signals from the external aerial (mounted on the roof or on the dashboard but with better external visibility, i.e. line of sight to GPS satellites) are routed along a co-axial cable that has to be plugged directly into the navigation device. This means that, to use an external aerial, a user has to first dock the device and then connect the RF cable to the device. This can be inconvenient.

Outside of the field of GPS navigation systems, it is known to connect a mobile telephone to a dock mounted on a car dashboard and for that dock to automatically connect the mobile telephone to an external aerial. Mobile telephones are of course used by ordinary individuals with no specialist training; because of this, it is very important that all aspects of the use of a mobile telephone are kept as simple as possible. Hence, it comes as no surprise that docks that automatically connect a mobile telephone to an external aerial are known. But for GPS navigation systems, simplicity of installation and use have not been seen as significant design considerations. Hence, despite the use of GPS navigation systems for personal and in-car use for very many years, to date all such systems have, when docked, needed the user to make a separate manual connection between electrical leads if an external aerial is to be used. This is the natural design choice for GPS navigation systems designed for users that are familiar and comfortable with electronic devices – the market niche that GOPS navigation systems have occupied for the last 10 years.

SUMMARY OF THE INVENTION

In a first aspect, there is a GPS navigation system comprising a dock in combination with a portable GPS navigation device, in which the device is programmable with map data and a navigation application that enables a route to be planned between two user-defined places, wherein the dock comprises:

(a) a RF connector designed to automatically interface with a RF connector in the device in order to feed RF signals from an external aerial to the device when the device is correctly mounted on the dock and

(b) a suction mount that enables the dock to be removably connected to a car windscreen..

As noted earlier, RF signals from an external aerial are conventionally routed along a co-axial cable that is plugged directly into the navigation device. This means that a user has to first dock the device and then hook up the RF cable. This can be inconvenient. But with the present invention, a user merely has to dock the navigation device onto the platform for an automatic connection to any external aerial connected to the dock to be made. There is no need to laboriously plug in a RF cable directly into the navigation device. Although superficially a small step, and one known from other fields such as mobile telephone docking systems, the realisation that the mobile telephone design approach of extreme simplicity of installation is also applicable to GPS navigation system design runs counter to the established design bias in this field. Yet it is precisely this kind of thinking that is fundamental to turning the GPS navigation system from a technophile's device to one with very widespread appeal.

The dock may comprise a platform that is rotatably mounted on an arm, the device being removably attached to the platform. The arm itself may then be pivotally mounted so that the platform can be moved vertically and horizontally. Docking the device onto the platform is very straightforward; the user merely has to move the device so that its base engages a lip on the platform; the user then rolls the device backwards, rotating it about the region where base and lip are touching. The lip is shaped to guide the device into correct alignment and engagement with the dock. The device then sits firmly on the platform, with the RF connectors on platform and device in good contact.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with reference to the accompanying drawings, in which **Figure 1** is a screen shot from a navigation device; the screen shot shows a plan map view and a status bar running along the bottom of the display;

Figure 2 is a screen shot from the navigation device implementing a 3-D view;

Figure 3 is a screen shot from the navigation device showing a navigation menu;

Figures 4A and 4B are perspective views of the navigation device and dock according to the present invention; and

Figure 5 is a schematic view of the system architecture for the navigation device;

Figure 6 is a schematic view of the navigation device, dock and external GSP aerial;

Figure 7 is a block diagram of components in the navigation device;

Figure 8 is a diagram of the electrical subassemblies in the **Figure 7** navigation device.

DETAILED DESCRIPTION

System Overview

The present invention is a dock for a navigation device from TomTom B.V. called Go. Go deploys navigation software called Navigator and has an internal GPS receiver; Navigator software can also run on a touch screen (i.e. stylus controlled) Pocket PC powered PDA device, such as the Compaq iPaq. It then provides a GPS based navigation system when the PDA is coupled with a GPS receiver. The combined PDA and GPS receiver system is designed to be used as an in-vehicle navigation system.

The invention may also be used for any other arrangement of navigation device, such as one with an integral GPS receiver/computer/display, or a device designed for non-vehicle use (e.g. for walkers) or vehicles other than cars (e.g. aircraft). The navigation device may implement any kind of position sensing technology for which an aerial that is external to the device itself may be desirable; it is not limited to NAVSTAR GPS; it can hence be implemented using other kinds of GNSS (global navigation satellite system) such as the European Galileo system.

Navigator software, when running on a PDA, results in a navigation device that causes the normal navigation mode screen shown in **Figure 1** to be displayed. This view provides driving instructions using a combination of text, symbols, voice guidance and a moving map. Key user interface elements are the following: a 2-D map **1** occupies most of the screen. The map shows the user's car and its immediate surroundings, rotated in such a way that the direction in which the car is moving is always "up". Running across the bottom quarter of the screen is the status bar **2**. The current location of the device, as the device itself determines using conventional GPS location finding and its orientation (as inferred from its direction of travel) is depicted by an arrow **3**. The route calculated by the device (using route calculation algorithms stored in device memory as applied to map data stored in a map database in device memory) is shown as darkened path **4** superimposed with arrows giving the travel direction. On the darkened path **4**, all major actions (e.g. turning corners, crossroads, roundabouts etc.) are schematically depicted by arrows **5** overlaying the path **4**. The status bar **2** also includes at its left hand side a schematic **6** depicting the next action (here, a right turn). The status

bar **2** also shows the distance to the next action (i.e. the right turn – here the distance is 220 meters) as extracted from a database of the entire route calculated by the device (i.e. a list of all roads and related actions defining the route to be taken). Status bar **2** also shows the name of the current road **8**, the estimated time before arrival **9** (here 2 minutes and 40 seconds), the actual estimated arrival time **10** (11.36am) and the distance to the destination **11** (1.4Km). The GPS signal strength is shown in a mobile-phone style signal strength indicator **12.** A 3-D map view mode is also possible, as shown in **Figure 2**.

If the user touches the centre of the screen **13**, then a navigation screen menu is displayed; from this menu, other core navigation functions within the Navigator application can be initiated or controlled. Allowing core navigation functions to be selected from a menu screen that is itself very readily called up (e.g. one step away from the map display to the menu screen) greatly simplifies the user interaction and makes it faster and easier.

The area of the touch zone which needs to be touched by a user is far larger than in most stylus based touch screen systems. It is designed to be large enough to be reliably selected by a single finger without special accuracy; i.e. to mimic the real-life conditions for a driver when controlling a vehicle; he or she will have little time to look at a highly detailed screen with small control icons, and still less time to accurately press one of those small control icons. Hence, using a very large touch screen area associated with a given soft key (or hidden soft key, as in the centre of the screen **13**) is a deliberate design feature of this implementation. Unlike other stylus based applications, this design feature is consistently deployed throughout Navigator to select core functions that are likely to be needed by a driver whilst actually driving. Hence, whenever the user is given the choice of selecting on-screen icons (e.g. control icons, or keys of a virtual keyboard to enter a destination address, for example), then the design of those icons/keys is kept simple and the associated touch screen zones is expanded to such a size that each icon/key can unambiguously be finger selected. In practice, the associated touch screen zone will be of the order of at least 0.7 cm^2 and will typically be a square zone. In normal navigation mode, the device displays a map. Touching the map (i.e. the touch sensitive display) once (or twice in a different implementation) near to the screen centre (or any part of the screen in another implementation) will then call up a navigation menu (see **Figure 3**) with large icons corresponding to various navigation functions, such as

the option to calculate an alternative route, and re-calculate the route so as to avoid the next section of road (useful when faced with an obstruction or heavy congestion); or recalculate the route so as to avoid specific, listed roads.

The actual physical structure of the device is fundamentally different from a conventional embedded device in terms of the memory architecture (see System Architecture section below). At a high level it is similar though: memory stores the route calculation algorithms, map database and user interface software; a microprocessor interprets and processes user input (e.g. using a device touch screen to input the start and destination addresses and all other control inputs) and deploys the route calculation algorithms to calculate the optimal route. 'Optimal' may refer to criteria such as shortest time or shortest distance, or some other user-related factors.

More specifically, the user inputs his start position and required destination in the normal manner into the Navigator software running on the PDA using a virtual keyboard. The user then selects the manner in which a travel route is calculated: various modes are offered, such as a 'fast' mode that calculates the route very rapidly, but the route might not be the shortest; a 'full' mode that looks at all possible routes and locates the shortest, but takes longer to calculate etc. Other options are possible, with a user defining a route that is scenic – e.g. passes the most POI (points of interest) marked as views of outstanding beauty, or passes the most POIs of possible interest to children or uses the fewest junctions etc.

Roads themselves are described in the map database that is part of Navigator (or is otherwise accessed by it) running on the PDA as lines – i.e. vectors (e.g. start point, end point, direction for a road, with an entire road being made up of many hundreds of such sections, each uniquely defined by start point/end point direction parameters). A map is then a set of such road vectors, plus points of interest (POIs), plus road names, plus other geographic features like park boundaries, river boundaries etc, all of which are defined in terms of vectors. All map features (e.g. road vectors, POIs etc.) are defined in a co-ordinate system that corresponds or relates to the GPS co-ordinate system, enabling a device's position as determined through a GPS system to be located onto the relevant road shown in a map.

Route calculation uses complex algorithms that are part of the Navigator software. The algorithms are applied to score large numbers of potential different routes. The Navigator software then evaluates them against the user defined criteria (or device defaults), such as a full mode scan, with scenic route, past museums, and no speed camera. The route which best meets the defined criteria is then calculated by a processor in the PDA and then stored in a database in RAM as a sequence of vectors, road names and actions to be done at vector end-points (e.g. corresponding to pre-determined distances along each road of the route, such as after 100 meters, turn left into street x).

Figures 4A and **4B** are perspective views of an actual implementation of a navigation device and dock. The navigation device is a unit **41** that includes display, internal GPS receiver, microprocessor, power supply and memory systems. The device **41** sits on a docking platform **45**; the platform **45** is rotatably mounted an arm **42** that can pivot horizontally about bolt post **46**. The arm **42** can also pivot vertically about posts **47**, which pass through apertures in a mounting arm which has a large suction cup **43** at one end. As shown in **Figure 4B**, the device **41** and docking platform **45** can rotate together; this combined with the vertical and horizontal degrees of movement allowed by posts **46** and **47** enables the device, when secured to the car dashboard using a large suction cup **43**, to be perfectly positioned for a driver.

One important detail of the design is that, whilst the device **41** includes an internal GPS receiver with an internal aerial, in some circumstances it is desirable to use an external GPS aerial (e.g. roof mounted). Normally, an external aerial would connect to a navigation device using a co-axial cable with a socket that plugs directly into the navigation device. But with the present system, the co-axial cable is fed directly to a RF aerial socket **44**, positioned on the docking platform **45**. When the navigation device is mounted correctly on the docking platform **45**, a RF connector internal to the device **41** engages the aerial socket **44** to feed RF signals from the external aerial to the device circuitry. If the driver rotates the device, then the device maintains engagement with the aerial socket **44** since socket **44** is part of the docking platform **45**.

System Architecture

In contrast to conventional embedded devices which execute all the OS and application code in place from a large mask ROM or Flash device, an implementation of the present

invention uses a new memory architecture. **Figure 5** schematically depicts the device. The device, indicated generally at **51**, includes conventional items such as a microprocessor **56**, power source **57**, display and related rivers **58**. In addition, it includes a SD card reader **53**; a SD card **52** is shown slotted into position. The device **51** has internal DRAM **54** and XIP Flash **55** and.

The device hence uses three different forms of memory:

1. A small amount of internal XIP (eXecute In Place) Flash ROM **55**. This is analogous to the PC's BIOS ROM and will only contain a proprietary boot loader, E^2 emulation (for UID and manufacturing data) and splash screen bit maps. This is estimated to be 256 KB in size and would be on a slow 8 bit wide SRAM interface.
2. The main system RAM (or DRAM) memory **54**, this is analogous to the PC's main memory (RAM). This will be where all the main code executes from as well as providing the video RAM and workspace for the OS and applications. **Note:** No persistent user data will be stored in the main system RAM (like a PC) i.e. there will be no "Ram drive". This RAM will be exclusively connected to a 32bit 100MHz synchronous high-speed bus.
3. Non-volatile storage, analogous to the PC's hard disk. This is implemented as removable NAND flash based SD cards **52**. These devices do not support XIP. All the OS, application, settings files and map data will be permanently stored on SD cards

On boot up the proprietary boot loader **55** will prompt for the user to insert the supplied SD card **52**. When this is done, the device will copy a special system file from the SD card **52** into RAM **54**. This file will contain the Operating System and navigation application. Once this is complete control will be passed to the application. The application then starts and access non-volatile data e.g. maps from the SD card **52**.

When the device is subsequently switched off, the RAM **54** contents is preserved so this boot up procedure only occurs the first time the device is used.

Device **51** also includes a GPS receiver with integral antenna; a RF connector **59** for taking in a RF signal from an external aerial is also provided. This is shown schematically

in **Figure 6**: the navigation device **61** is mounted on docking platform **62**; as noted earlier, docking platform **62** includes a RF connector **63** that engages with the RF connector in the device **61** to pass RF signals from GPS satellites to the device **61**. An external aerial **65** is connected via co-axial RF cable **64** to the connector on the platform **63**. In this way, a user merely has to dock the navigation device onto the platform for an automatic connection to any external aerial to be made. There is no need to laboriously plug in a RF cable directly into the navigation device. Although Go has an internal GPS aerial, an external aerial is sometimes necessary because certain kinds of windscreen glass (e.g. with special coatings) may absorb the signals sent from the GPS satellites.

The following other signals are also connected via the dock to the navigation device:

1. Power from the vehicle
2. A signal to automatically mute the car audio system during a spoken command
3. A signal to switch on and off the device automatically with the vehicles ignition switch or key
4. Audio output signals to play spoken commands on the vehicles audio system.